



DARPA Tech 2000

Robust Passive Sonar

Dr. Thomas J. Green, Jr.
Program Manager
September 2000

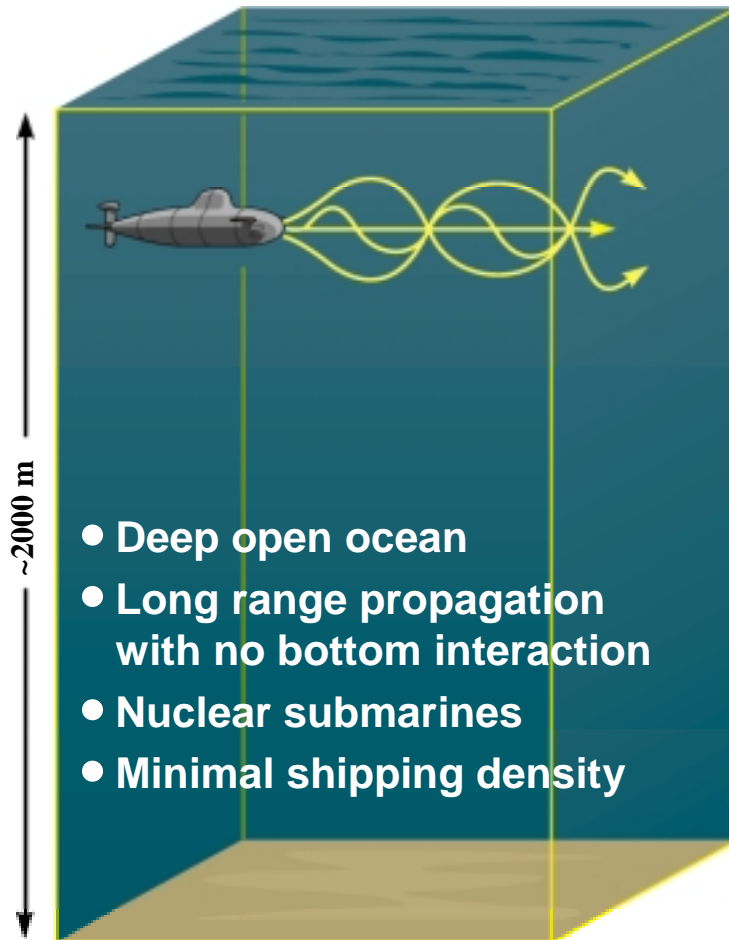


Anti-Submarine Warfare (ASW)

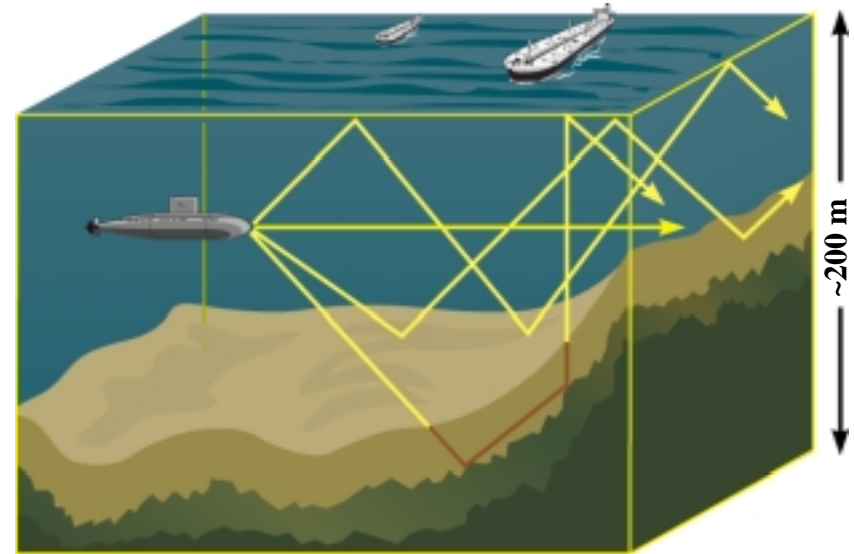


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Cold War ASW



Current Littoral ASW



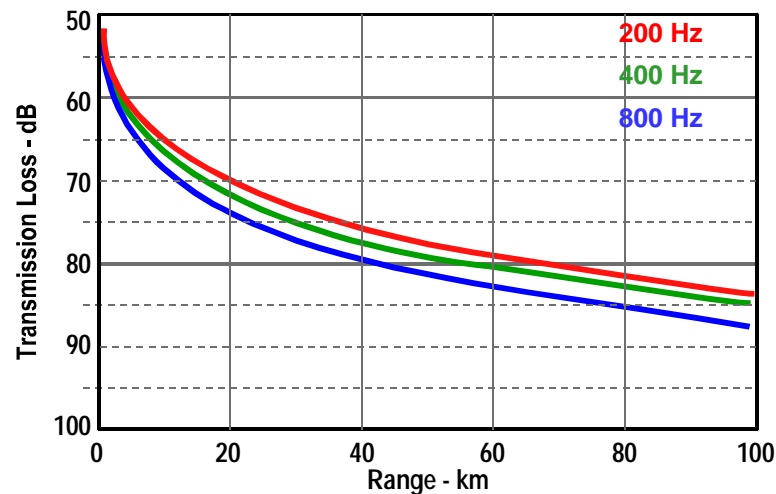
- Shallow water coastal regions
- Multipath propagation with significant attenuation
- Quiet diesel-electric submarines
- Significant shipping noise interference
- Dynamic engagements



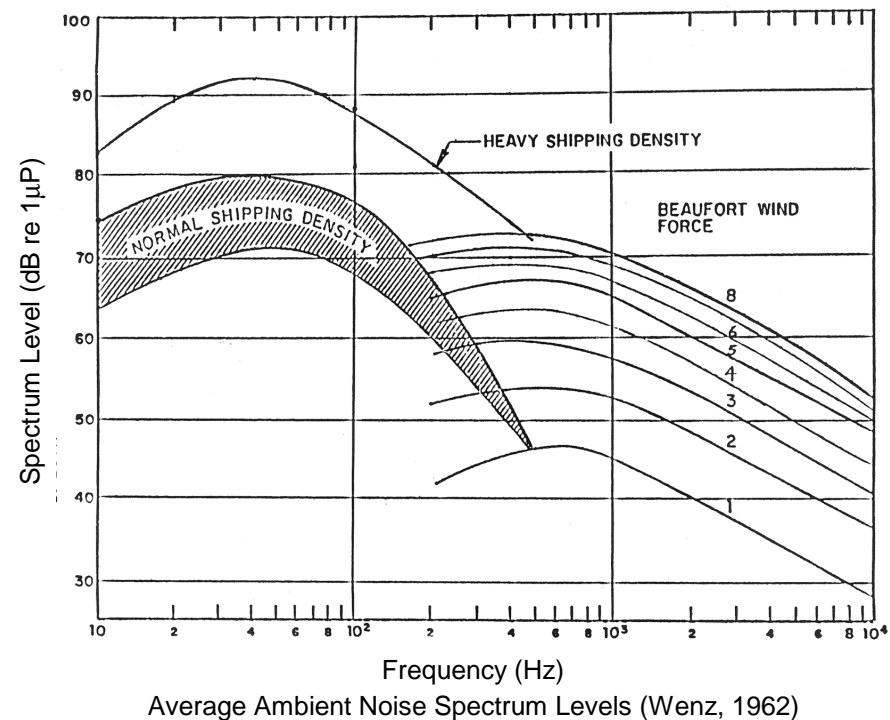
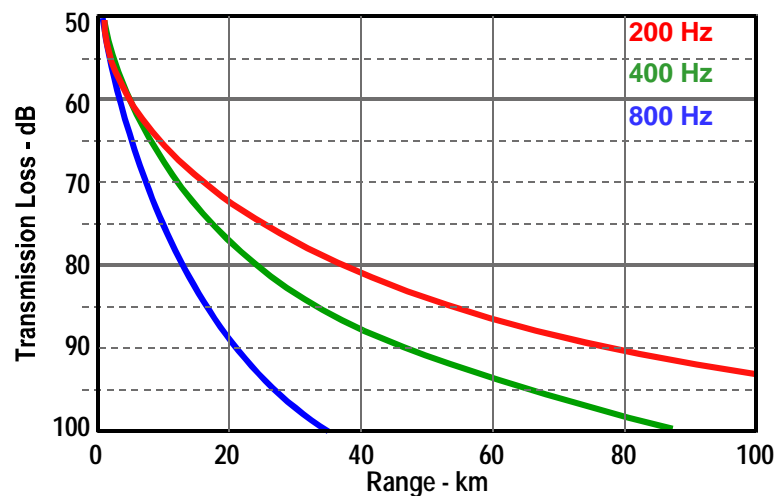
Littoral ASW Implications



April
Strait of Korea



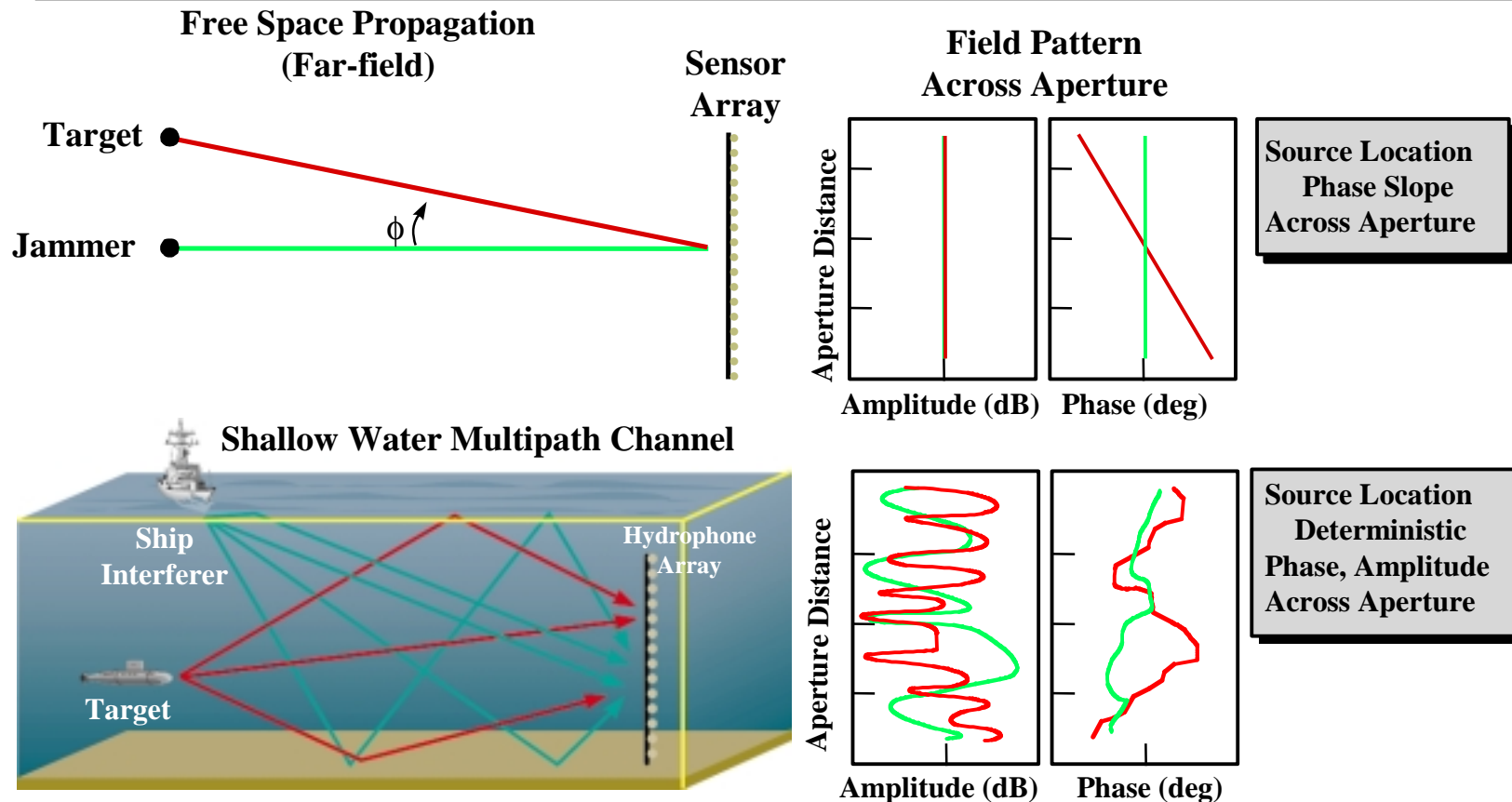
September



Loss of sensitivity due to heavy shipping density can produce dramatic reductions in detection range



Matched Field Processing (MFP)



- Steering vector derived from propagation model
- Exploits channel multipath for detection/localization
- Adaptivity rejects interference and reduces sidelobes
- Main issues
 - Robustness to environmental uncertainty
 - Estimating scene statistics with limited snapshots

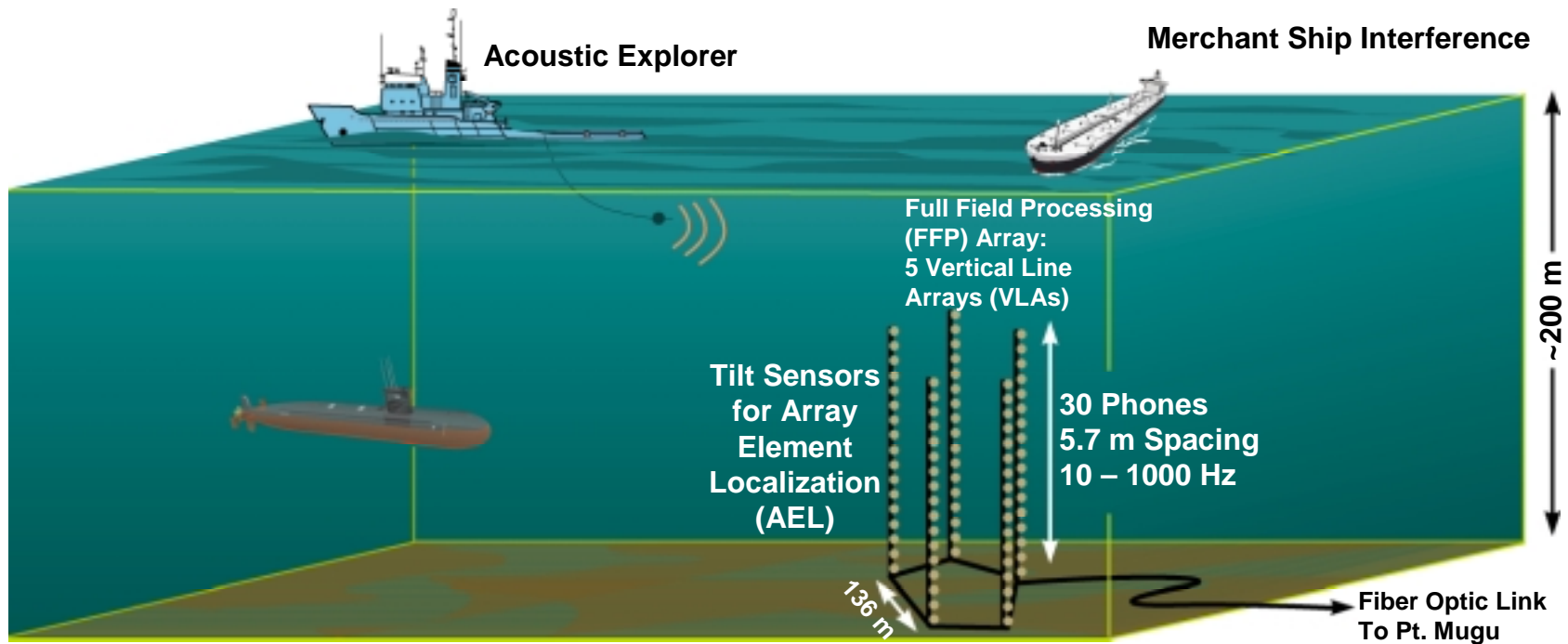


SB Channel Experiment (SBCX)



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Santa Barbara Channel Experiment (SBCX)

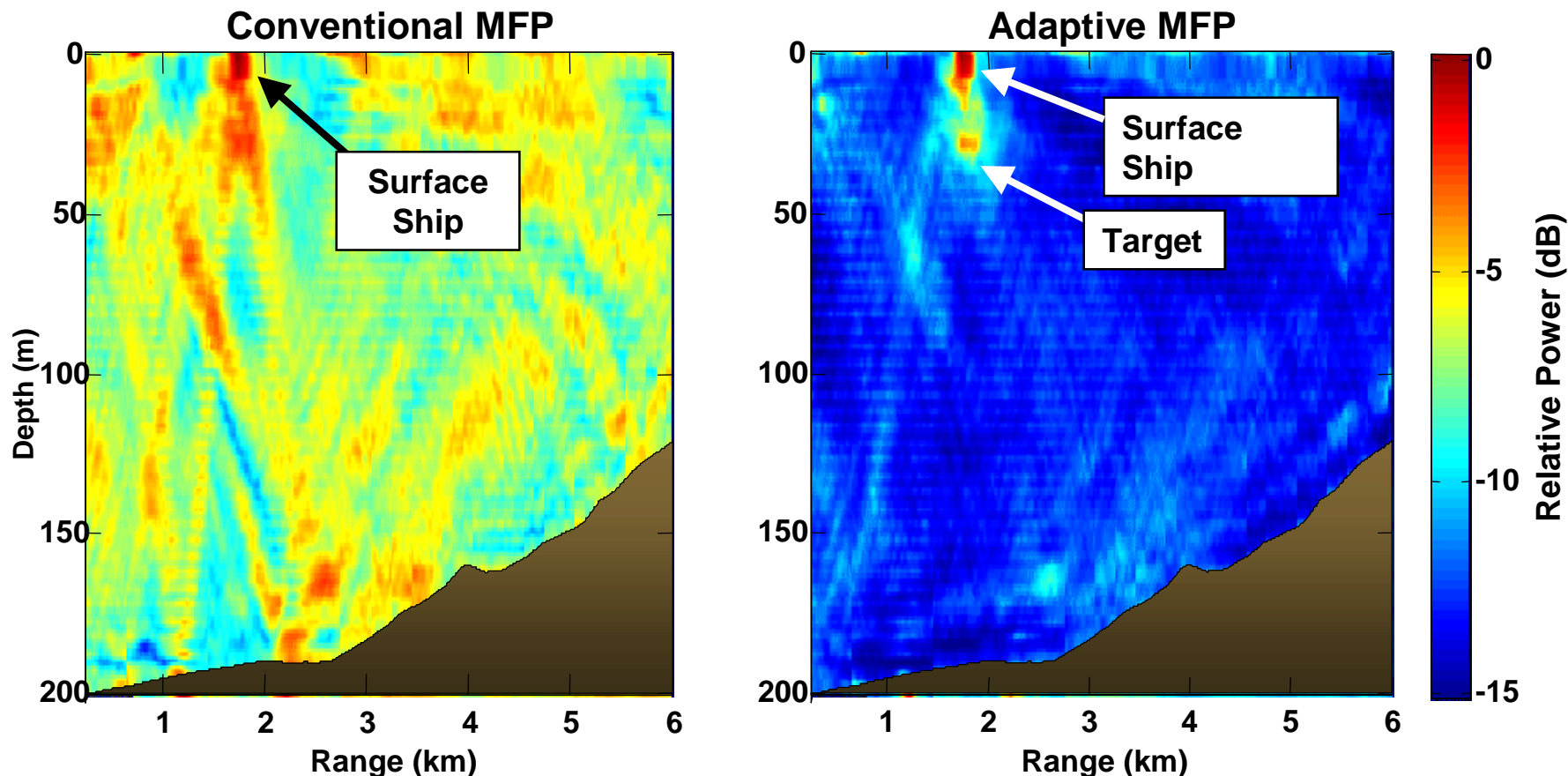


Objectives:

- Establish fundamental limits to signal and noise gains with Adaptive Matched Field Processing (AMFP) for passive broadband detection, localization, and classification
- Extrapolate measured performance to other threats, environments, and sensors of interest



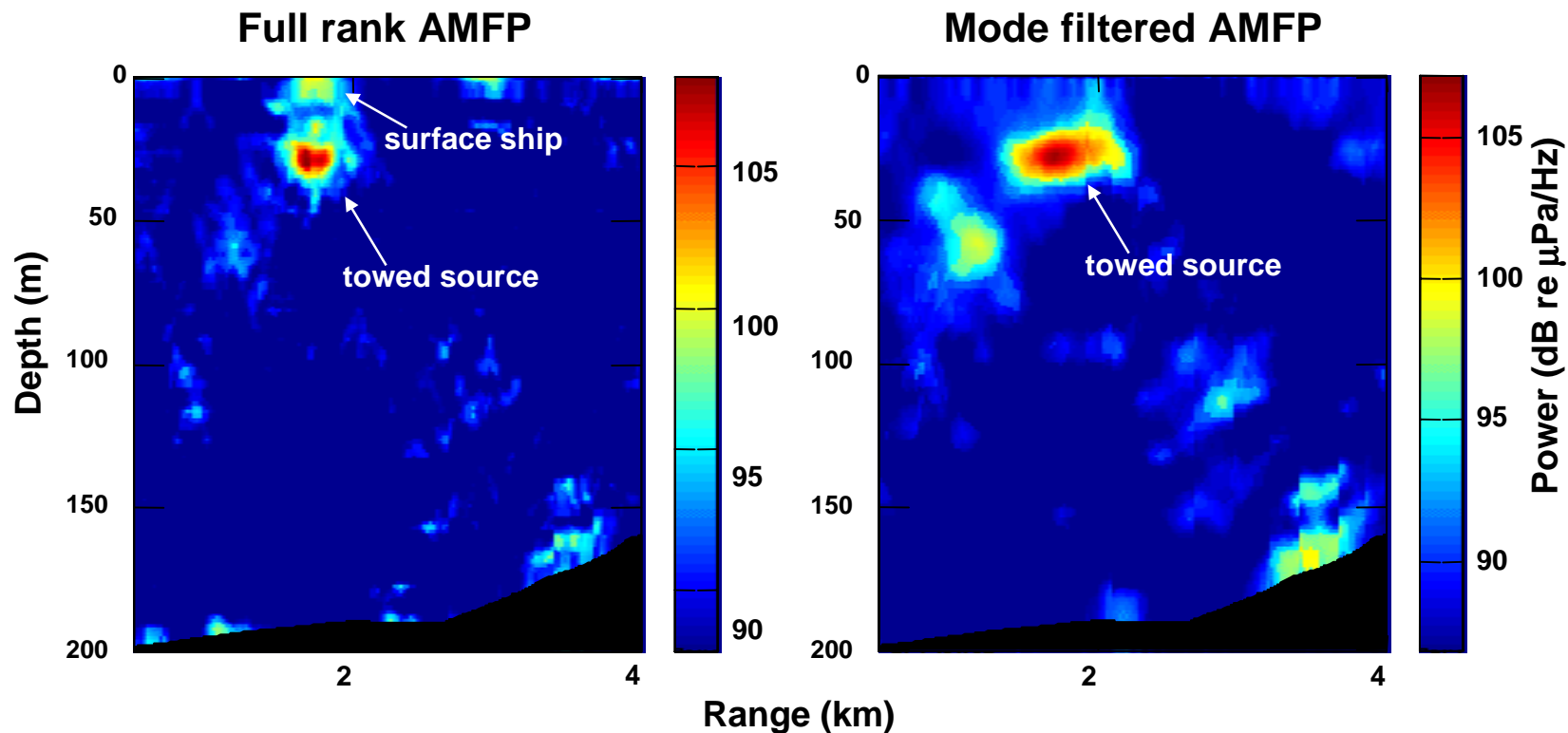
Adaptive Target Localization with Surface Ship Interference



AMFP utilizes adaptivity and environmental knowledge to provide correct localization of weaker, submerged source in the presence of surface interference



Adaptive MFP with Mode Filtering



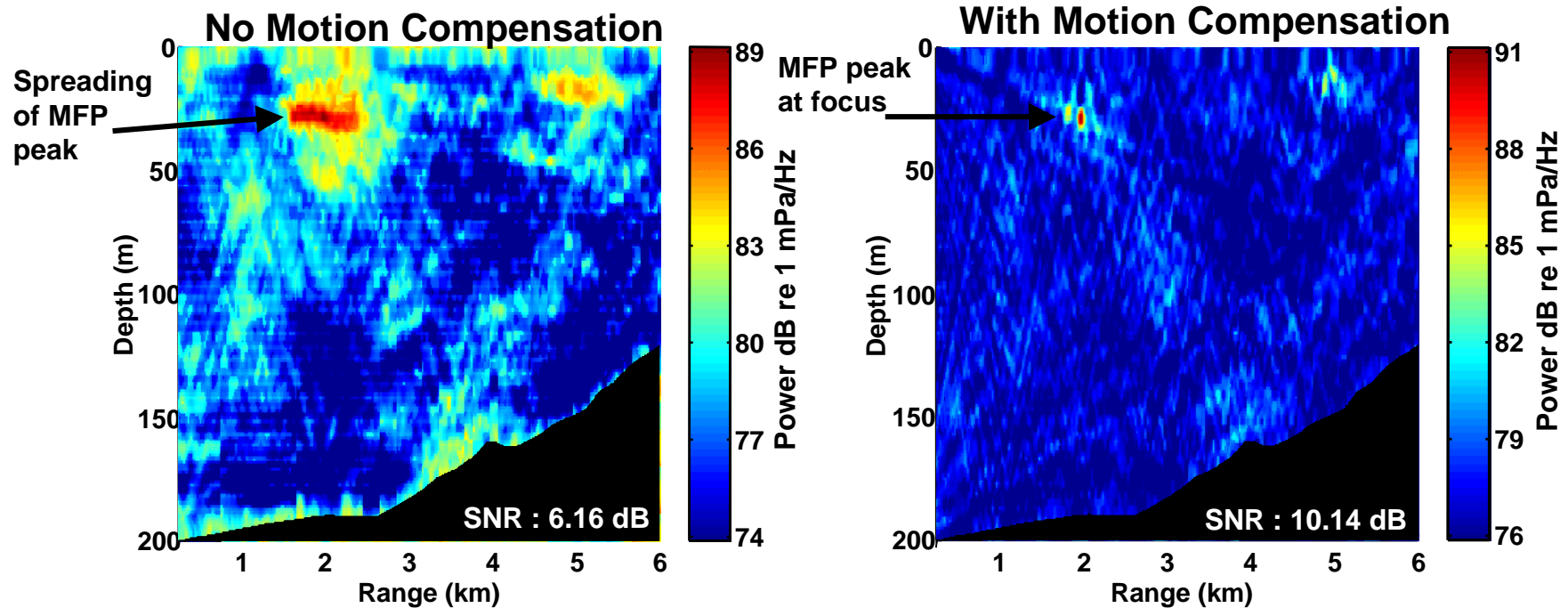
- **Modal filtering is designed to remove energy from surface interference while retaining submerged source**
 - Lessens requirements for adaptive snapshot support
 - Broadens MFP beam, decreasing losses from motion and environmental mismatch



Motion Compensation Processing



Actual range (GPS) 1.70 to 2.45 km

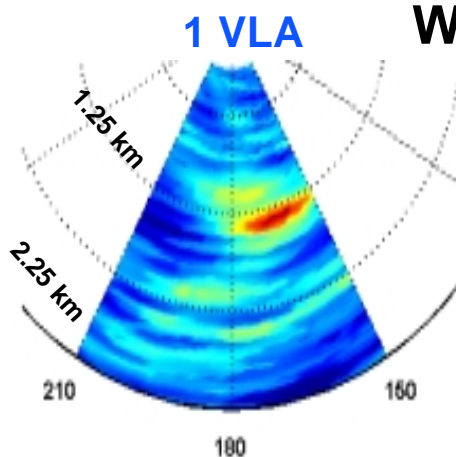


AX2 235 Hz augmentation tone
Observation time T=300 sec with 1 sec FFT window

- Motion compensation matrix adjusts for phase difference and amplitude ratio of moving target as a function of time
- Compensation increases signal gain and mitigates sidelobes
 - Eliminates smearing loss of 4 dB in the interference-free scenario
 - Additional SINR gain when interferers on different tracks are de-focused

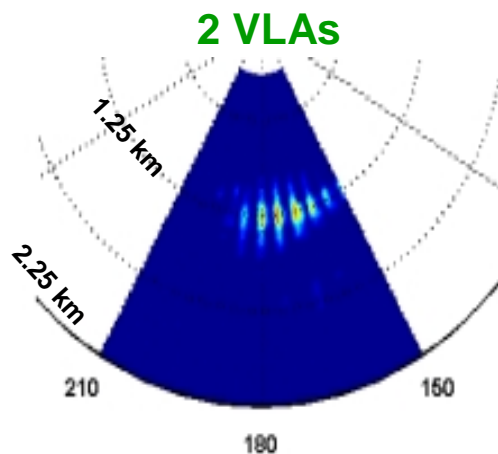
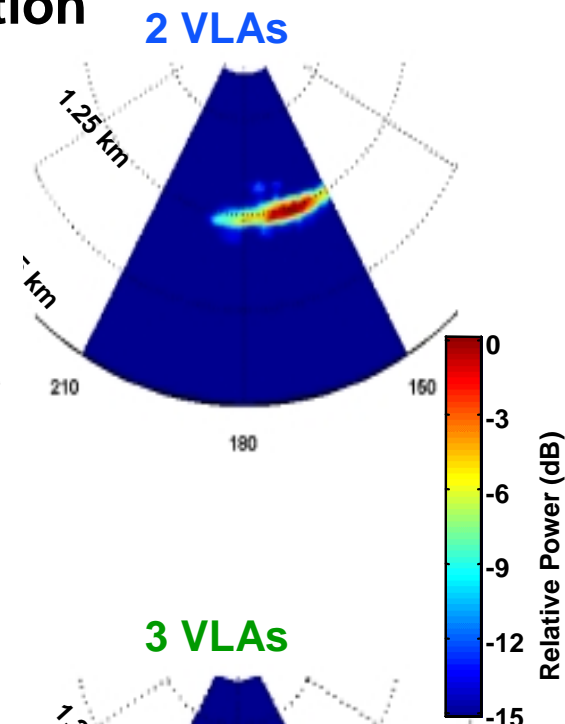


Multi-VLA Processing with Motion Compensation



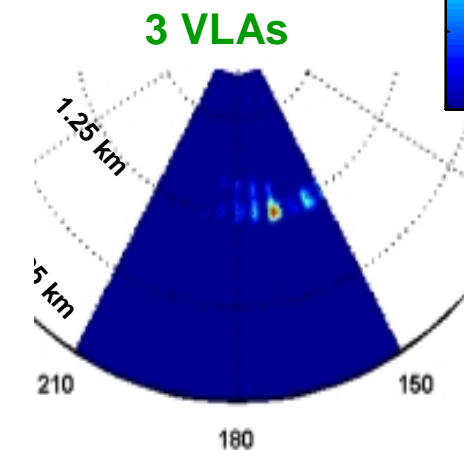
Without Motion Compensation

- Tilt of single VLA gives coarse bearing
- Multiple VLA processing gives incoherent average
- Full array resolution not achieved



With Motion Compensation

- Differential Doppler across FFP baseline corrected prior to covariance estimation
- Full array resolution achieved with compensation



Data: AX2, 235 Hz



Robust Passive Sonar



Target sensors:

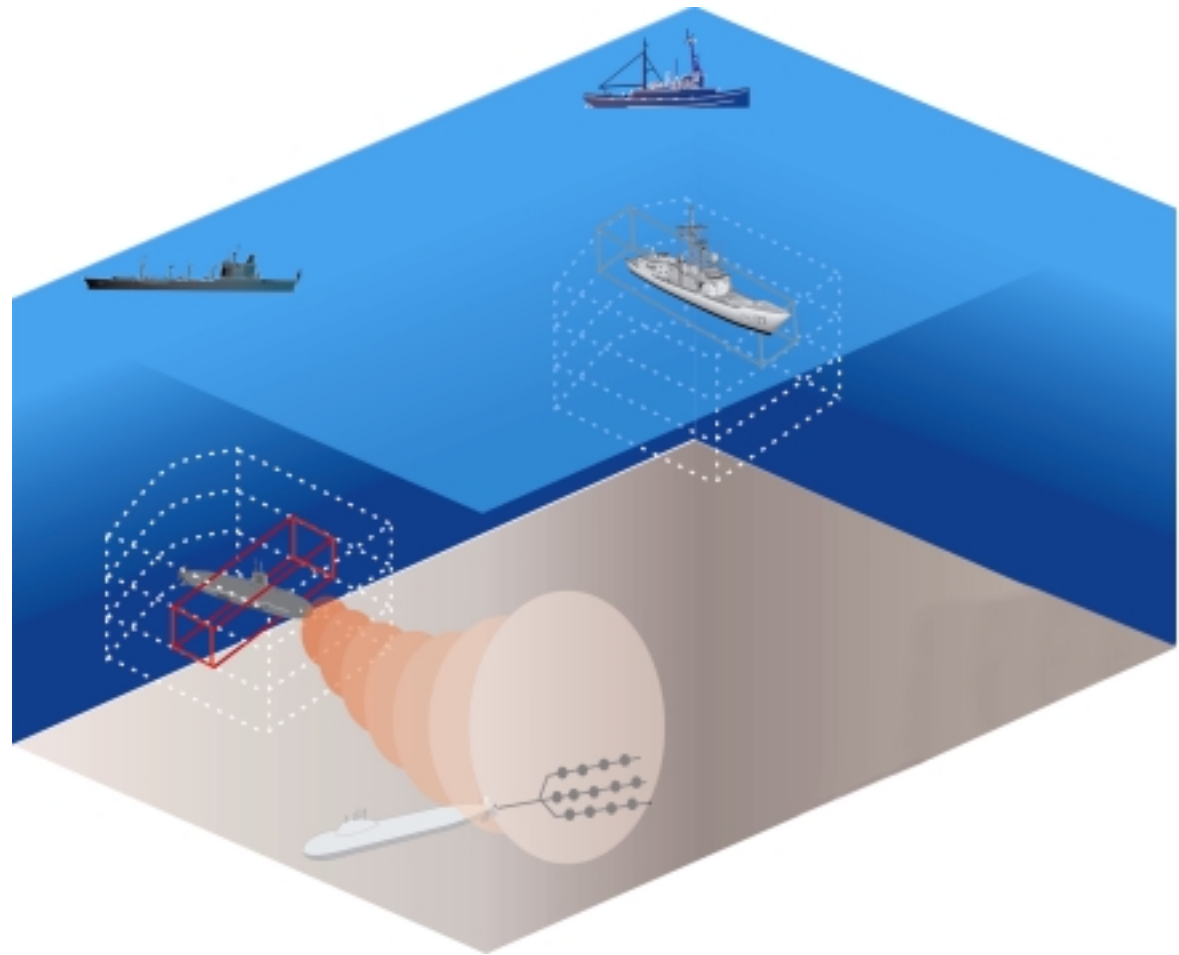
TB-29

- Large aperture with many elements
- Heading sensors to support advanced processing

SURTASS

Twin Line

Prototype Sensors



***Revolutionary Tactical Control for Littoral ASW:
> 10 dB Gain in Figure of Merit***



Approach



- **Conduct system analysis for performance assessment**
- **Extend SBCX concepts to tactical systems**
- **Integrate processing techniques into end-to-end sonar**
- **Conduct focused sea tests and experiments**
- **Utilize high-quality, ground-truthed tactical data sets to verify performance**



We Need Your Help!



Technology Areas

- **Systems analysis**
- **End-to-End processing systems**
- **Advanced beamforming concepts**
- **Automation**
- **et al.**

Procurement Plans

- **Broad Agency Announcement**
- **Unsolicited white papers**

New Ideas Needed